Senior Design Project

Initial Document

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KNIGHT-STATION

(SOLAR POWERED INTELLIGENT BIKE RACK SYSTEM)

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~*Project Narrative Description*~

In recent years, more and more students are using a bicycle as their main transportation to campus because of numerous benefits it offers. Firstly, by using a bike to go to school, it can help students from being stuck in crowded traffic. Secondly, riding a bike to school assists in preventing environmental pollution. However, there are few problems that bike owners usually have to deal with daily and those problems can become significant if they're not addressed seriously. One of the first reasons why students are afraid to use their bikes to go to class is that their bikes can get damaged due to many external factors such as harshness of weather (raining), colliding with other bikes, etc. A bike is not an inexpensive thing to buy, and it can become extremely costly to the bike rider if it is not maintained properly. So the first problem we identify is a proper bike storage place for a bike owner. Another factor that can become a major issue is the security and convenience for the bike owners. Whoever owns a bike would be concerned more about the issue of bike theft. Even with the advancement of modern bike lock technology, bicycle theft rates are still at a significant level. In an article regarding bike theft "the article link is in the reference section", it is stated that the number of the bikes being stolen nearly reached to 200,000 bikes across the US in 2008 according to the Federal Bureau of Investigation. Therefore, students who own a bike, and use it frequently, risk exposing their bikes, and themselves, to this unfortunate event..

Knight-Station will be the solution to all these problems. The main goal of this project is to help to solve the problems that the students who own bikes currently have to deal with every day when it comes to storage place, security, and convenience. Also, with a few add-on features being designed and installed on the system, it will surely provide many great benefits to the bike owners.

So what is the Knight Station? how can it provide benefits to the bike owner? Knight Station is a new concept for bike storage system. The bike rack will be fully covered by a roof where the solar power will be mounted on top of it. The purpose of having the roof cover for the bike rack is to protect the bike, and to have a strong foundation that can support the solar panel system. The solar power will be the main power supply to the whole bike rack system, and it is an off-grid type so the whole system can be installed at any desired place. The main purpose for the idea of choosing an off-grid type over the tie-to-grid type solar system is to be easily relocated and installed. The lock system for the bike rack is designed specially for security and convenience purposes. First, it is designed to be accessible for all types of bike. With a careful design plan, our lock system will not only fit to all bikes but also provides better security. All the locks will be controlled mainly by the microcontroller and it have the ID card reader feature, which means only students who have valid school ID can have access to the locks. This provides the most convenient and secure way for students to store their bikes. In addition to our bike rack lock system, we also have some great add-on features to provide for bike owners such as the AC power outlet charging station where students can charge their bikes while they are in class, the LED strip lighting system with a smart sensor that will turn on the lights when it's dark outside, and the security camera with motion detector feature that will record when there is a moving object near the system. All of these features are designed thoroughly to maximize the security for bike owners.

Another problem is seen, not by the users, but by UCF itself. After the end of semesters, students are in a hurry to travel back home and many times they leave their bikes locked to a rack. During the down time, UCF begins to put notices on the bikes for the owners when they return. However, due to unforeseen events the owners do not return and UCF is stuck with the problem of a locked bike taking up room, preventing other students of using the space. KnightroStation provides the correct solution, as the system will know who the bike belongs to, hence the purpose of swiping the UCF ID. This way, during term breaks, the system (or a crew member) can access the database and notify the owner that his/her bike

is still on the racks. If the bike is left unattended, UCF can take custody of the bike, removing it from the rack (freeing space) and notifying the owner of when and where they can pick up their bike.

One more concept that we have recently added to our system is the bike rental service. The bike rental service is created based on the interests and high demands from students. We acknowledge that students find it inconvenient to travel between classroom buildings with a short time gap between. The result for this inconvenience is being late to class which is not fair for students. Therefore, the idea of the bike rental service is created to be the solution for these inconvenient problems. Every student with valid school ID will have full access to this service. After swiping their ID to the system, students will be provided with different time range options for their bike rental. Students must return the bike back to the station before the time runs out. In the case that the bike is returned after the time runs out, the system will send the data of the person who rented the bike to the school system.

The objective for this project is to apply our knowledge and experiences in electrical engineering studies to a solve real world problem. We want to plan, design, and engineer a product that not only delivers a better solution to the problems presented, but also brings the benefit to the users. From an electrical engineering perspective, we want to build our own circuit systems in the most cost effective way, yet maximize the performance. In addition to a cost effective strategy, we also want to design an energy efficient project. Our system involves renewable energy technology as the main power supply and designed with a low-power device technology.

Group Members

We divide our team into four main group to focus into four different areas of the project: **power system**, **electrical distribution system**, **applications**, and **embedded system**.

Name	Major	Area of interest	Project design
The Pham	Electrical Engineering	Electric Power System and Electronic Device	Photovoltaic Devices Charge Controller Battery Bank Electric lock
Nha Nguyen	Electrical Engineering	Electronic Device and Integrated Circuit Design	DC voltage converter DC to AC inverter DC distributors
Christine Erwin	Electrical Engineering	Electric Power System and Application	Security Camera Motion Detection Light Sensor
Daniel Adarme	Electrical Engineering	Embedded system and communication system	Microcontrollers Electric Lock system Programming

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Specifications and Requirements

Power

- The project will be energy sufficient through solar panels (4) that will be implemented on top of a roof. The roof will double as a shelter for the bike(s).

- There will be batteries (3) for backup. The reason for this is for AC charging capabilities, night-time operations and possible power shortage from the panels.

- The charge distribution will be controlled by one charge controller that will direct the distribution of power from the solar panels to the batteries and to the MCUs, LCD screen, and magnetic locking system.
- There will be a light sensor to detect insufficient daylight.
- Total time running for the system will be approximately 12 hours.
- One DC-to-AC converter for AC charging capabilities. This is for promoting green energy as electric bikes are more affordable for college students.

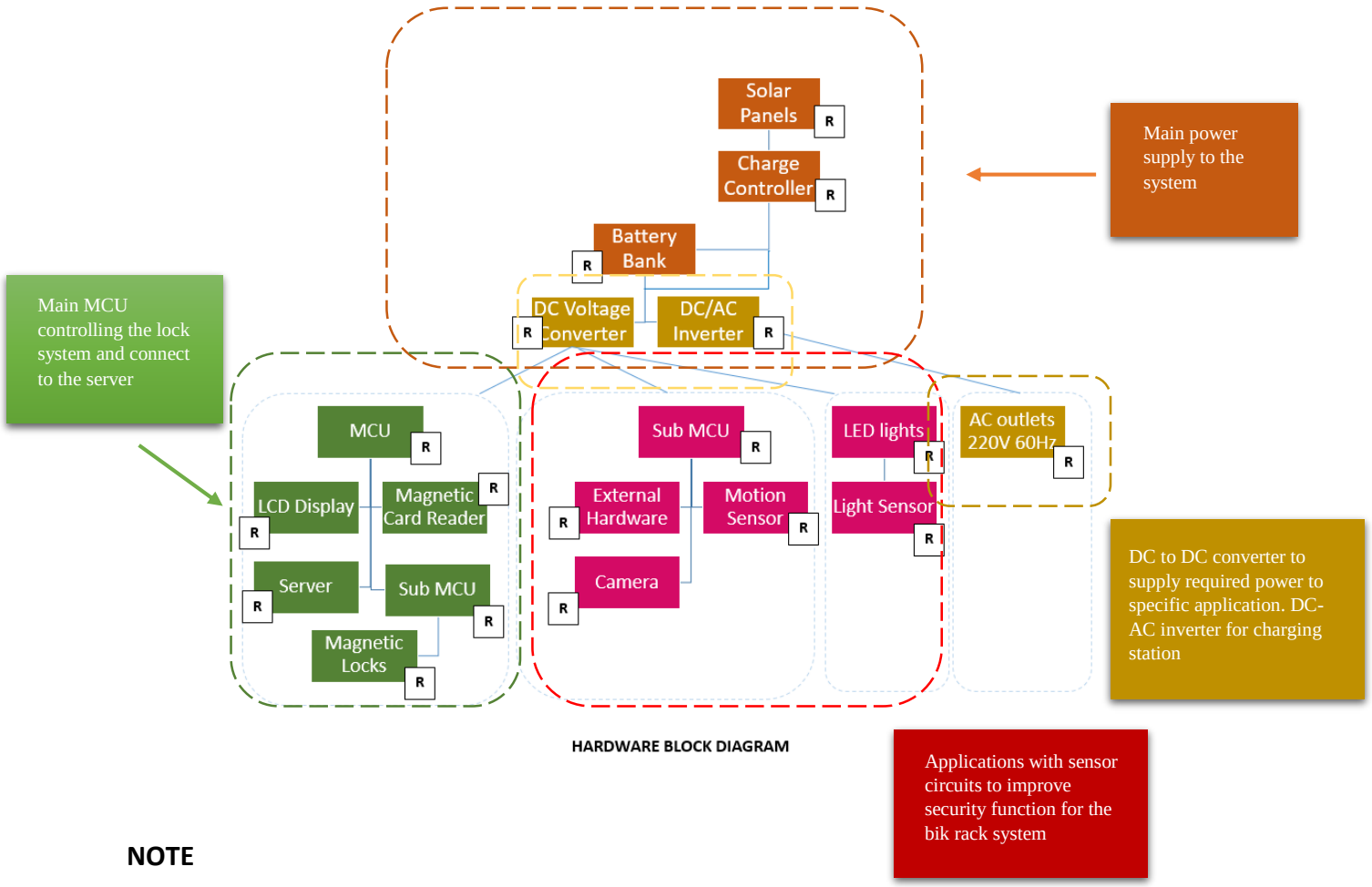
User Interface

- Low-power system that will remain awake for only a few minutes.
- The main MCU will drive the LCD screen, sub MCU and card reader.
- A second MCU will be used for the lock mechanisms
- There will be a magnetic card reader which will authenticate UCF Students. If person is not a UCF student, they must swipe a credit card.
- The LCD screen should be optimal for outdoor use with daylight.
- When a student completes the process of authentication, the bike should be unlocked for a short amount of time to the user.
- Identification (unknown implementation) tags will be placed on the bikes for identification purposes for the system. This is effective when renting the bikes out.
- Identification tags will enabling proper data logging for usage purposes.
- The system should provide convenient interaction with the user.
- All corresponding data will be driven to a cloud-based server where student authentication will take place and correct data logging for pick-up/drop off.

Security

- There will be a low-power security system which will be activated with a motion sensor.
- The security camera will be an LPM system, running for only 10 minutes at a time when motion is detected.
- The footage from the cameras will be stored on an external hard drive and will be extracted and cleared in corresponding intervals.
- The docking station along with RFID tags will be an additional theft-deterrent specification.
- Electronically controlled mechanical locking mechanisms will secure bikes.

Block Diagram



HARDWARE BLOCK DIAGRAM

NOTE

- Thai Pham
- Nha Nguyen
- Daniel Adarme
- Christine Erwin

T To be acquired - meaning the block will be purchased or donated

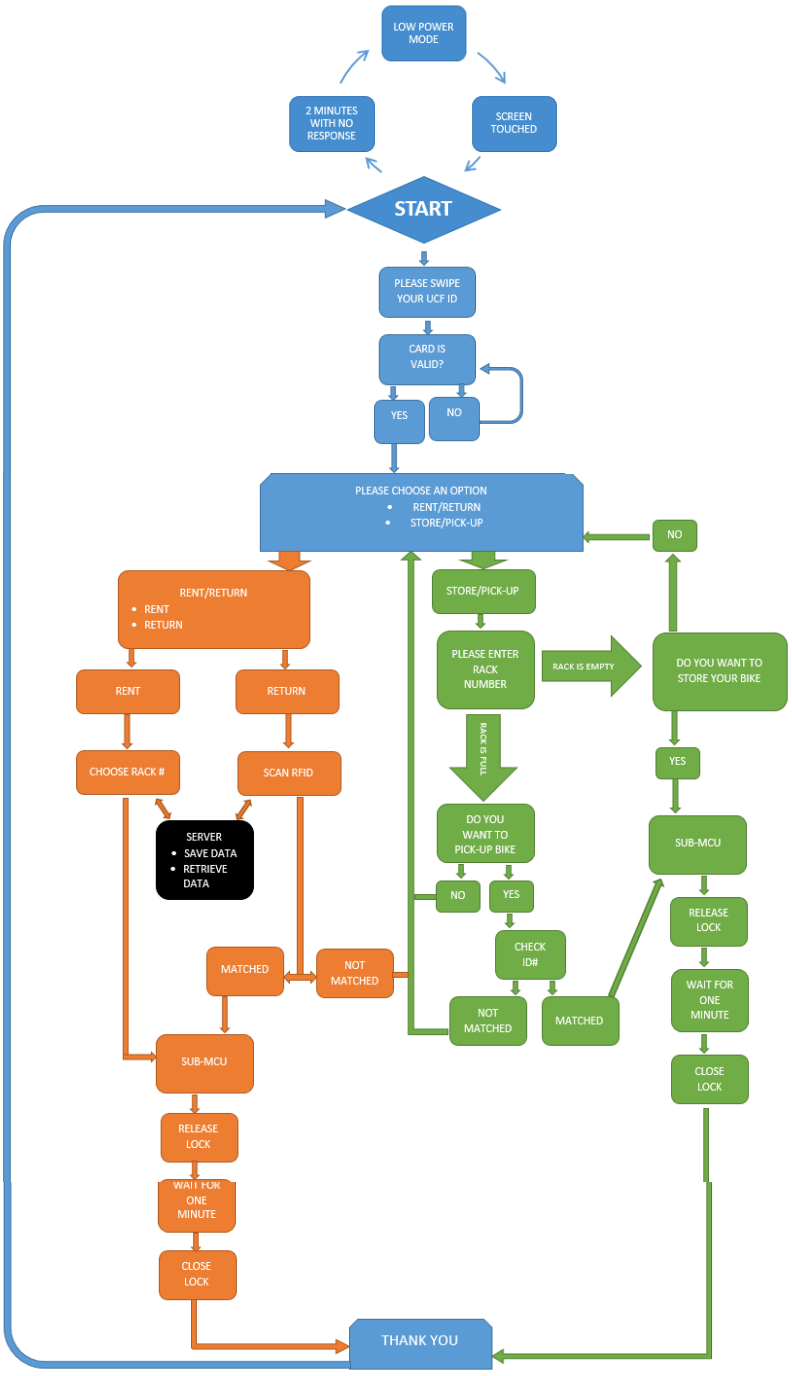
A Acquired - block has been donated or purchased

R Research - block design approach is being investigated

D Design - block is currently being designed

P Prototype - block is currently being prototyped

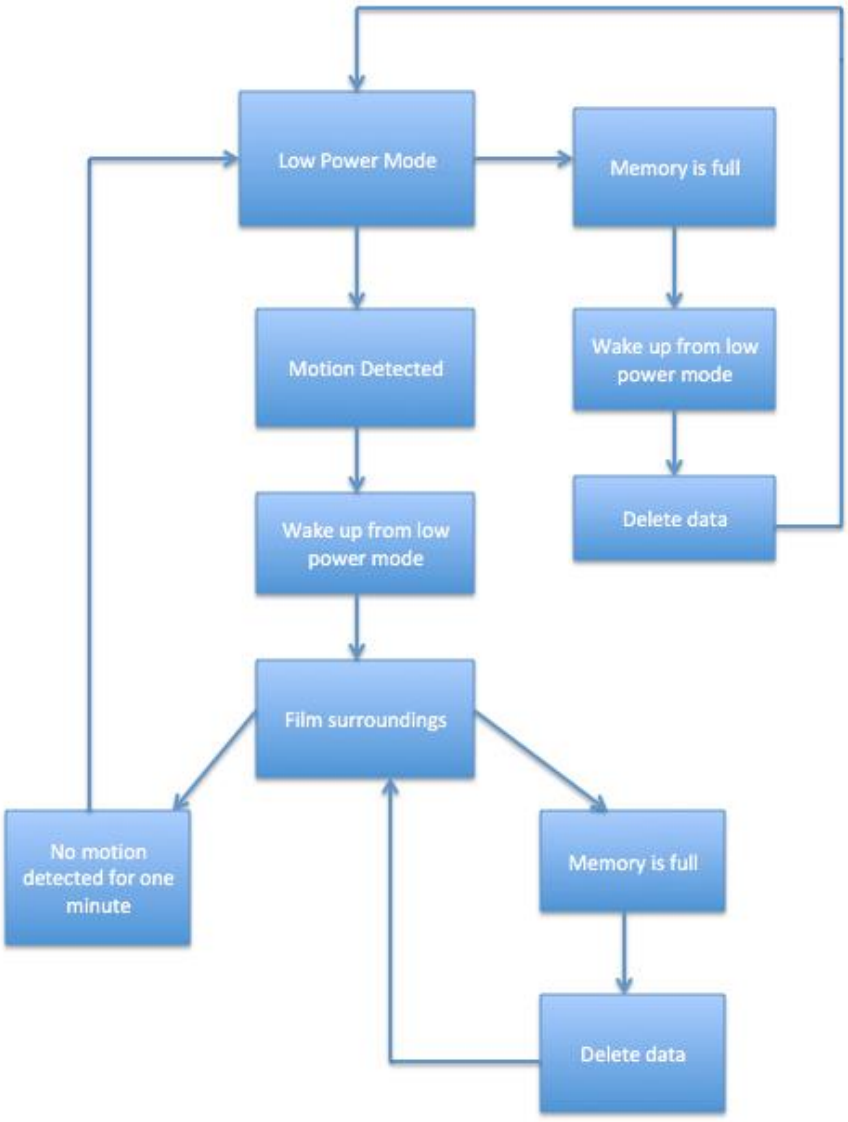
C Completed - block design is a finished prototype



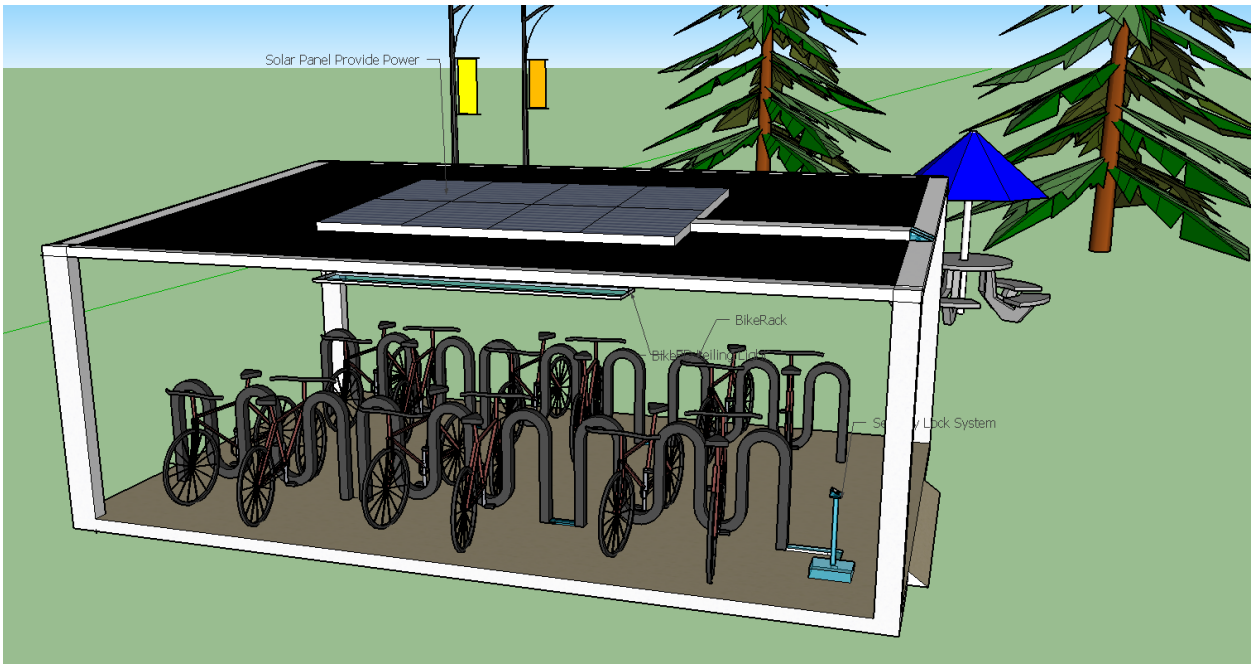
SOFTWARE BLOCK DIAGRAM

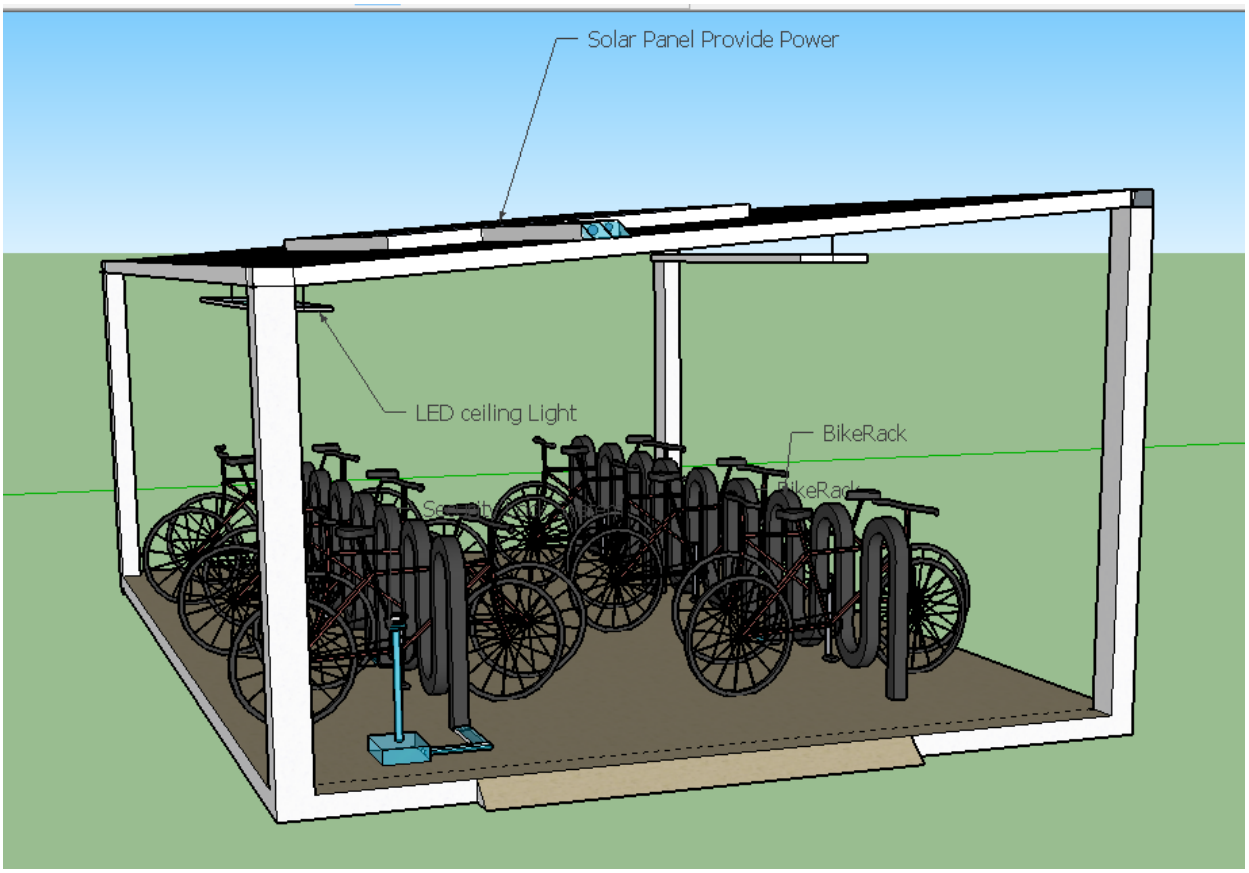
USER INTERFACE/SOFTWARE FLOW DIAGRAM

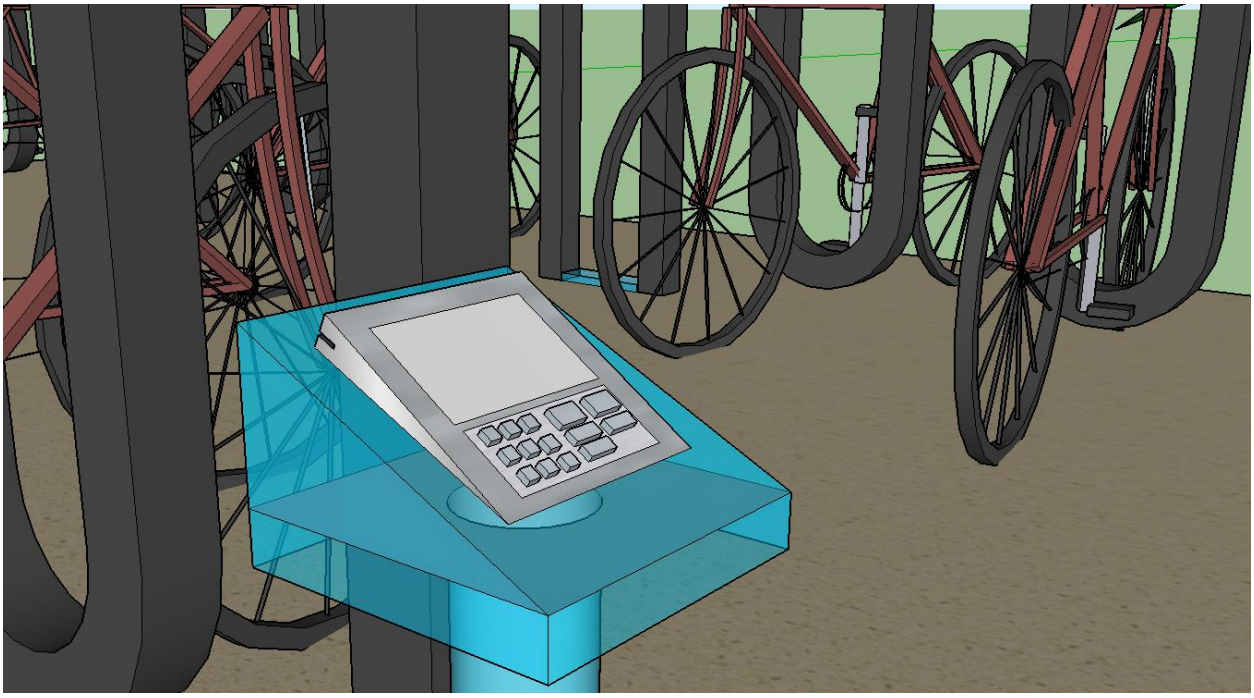
Security Operation Flow Chart

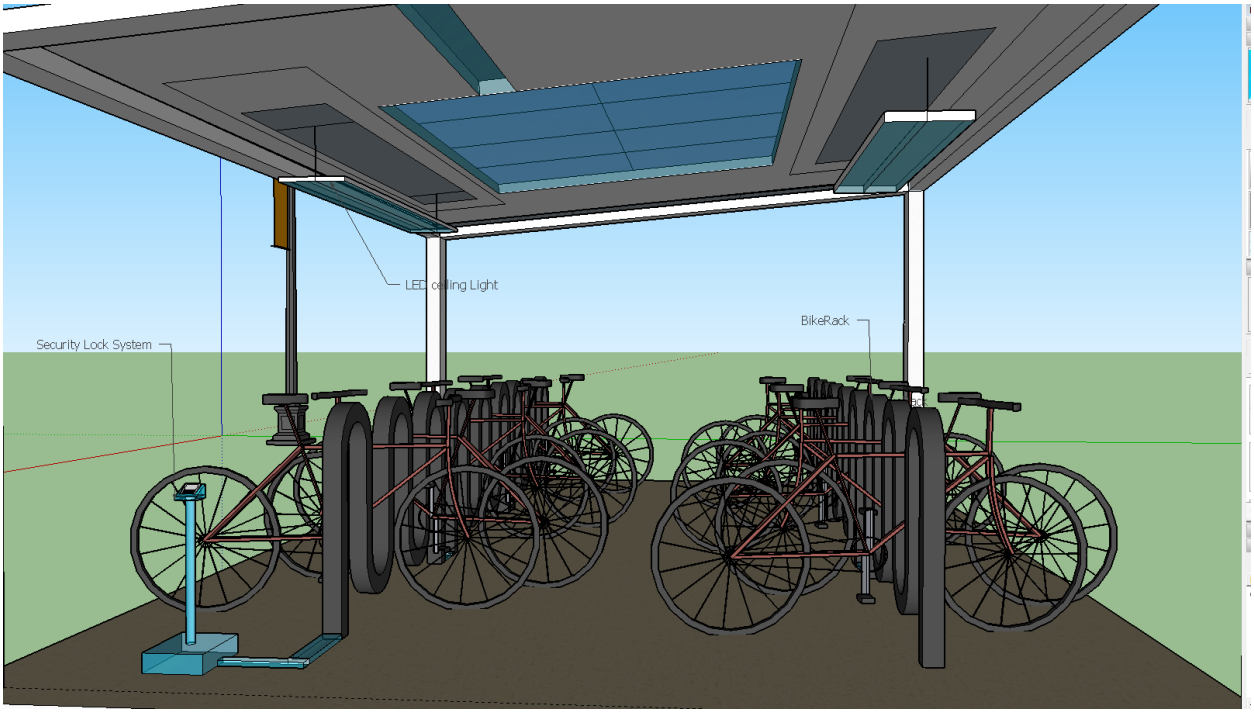


Project Prototype Illustration








LED ceiling Light
Security Lock System
BikeRack

Project Budget List Estimation

Name	Quantity/Types	Price	Status
Solar Panel	2x(150 watts offgrid solar panel)	$330	research
Charge Controller	1 (component)	$30	research
Battery	2x(12V 100Ah Deep Cycle Battery)	$336	research
DC-DC inverters	3x(build)	$70	research
DC-AC inverters	1	$30	research
Experimental Board	1 (TI)	$149	research
Sub-MCU	3x(TI)	$60	research
Phototransistor	1	$5	research
camera	1	$25	research
microcontroller for camera	1	$40	research
LED strip	1	$15	research
External hard drive	1	$65	research
Motion Sensor	1	$12	research
Others	shipping cost, material cost	$333	research
	Total	**$1,500**	research

Project Milestone for Both Semesters

Senior Design 1		
Week Number	**Week Start Date**	**Objectives**
3	1/25/2016	turn in initial document find funding
4	2/1/2016	schedule appointment with Dr. Richie start working on final document find funding
5	2/8/2016	complete final document
6	2/22/2016	mid-term preparation
7	2/29/2016	order parts
8	3/7/2016	order parts
9	3/14/2016	spring break
10	3/21/2016	prototype
11	3/28/2016	prototype
12	4/4/2016	prototype
13	4/11/2016	prototype
14	4/18/2016	prototype
15	4/25/2016	prototype
16	5/2/2016	prototype
17	5/9/2016	prototype
Senior Design 2		
Week Number	**Week Start Date**	**Objectives**
1	5/16/2016	testing
2	5/23/2016	testing
3	5/30/2016	testing
4	6/6/2016	testing
5	6/13/2016	project complete
6	6/20/2016	troubleshooting
7	6/27/2016	troubleshooting
8	7/4/2016	troubleshooting
9	7/11/2016	troubleshooting
10	7/18/2016	troubleshooting
11	7/25/2016	troubleshooting
12	8/1/2016	showcase

Decision Matrix

Referrence

Article about bike theft:

http://www.bikeradar.com/us/news/article/bike-theft-on-the-rise-in-the-us-27021/

Battery:

http://www.amazon.com/100Ah-SOLAR-WIND-CYCLE-BATTERY/dp/B00S1RT58C/ref=sr_1_1?s=electronics&ie=UTF8&qid=1453503011&sr=1-1&keywords=deep+cycle+solar+battery

Solar Panel:

http://www.ebay.com/itm/Two-New-Mono-Solar-Cynergy-150-Watt-12-Volt-Solar-Panels-150-W-Watts-12-V-Volts-/271819504189?hash=item3f49b47a3d:g:360AAOSwNSxVFIif

Raspberry Pi camera module:

http://www.amazon.com/Raspberry-5MP-Camera-Board-Module/dp/B00E1GGE40

Raspberry Pi 2 Model B Project Board - 1GB RAM - 900 MHz Quad-Core CPU

http://www.amazon.com/Raspberry-Pi-Model-Project-Board/dp/B00T2U7R7I/ref=pd_bxgy_147_2?ie=UTF8&refRID=11ZZG9C6D5DRYCC9EWJJ

Flexible LED Light Strip with 300xSMD3528

http://www.amazon.com/LEDwholesalers-Flexible-300xSMD3528-Adhesive-2026WH/dp/B002Q8V8DM

External Hard Drive

http://www.amazon.com/Black-Passport-Ultra-Portable-External/dp/B00W8XXRPM/ref=lp_595048_1_1?s=pc&ie=UTF8&qid=1453424402&sr=1-1

Motion sensor

https://www.adafruit.com/products/189